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Abstract

POWER LEVEL TEMPERATURE COEFFICIENT BY ZERO POWER MEASUREMENTS

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The reactivity effects of temperature changes in a research or power reactor under various operating conditions is usually determined by experimental measurements. This generally requires a series of experiments in which each type of operating mode is explored. A simple experimental method is described here in which zero power experiments permit evaluation of temperature coefficients applying to any mode of power range operation.

The method has been used for measurements in a pool reactor but it could be applied to other types of reactors as well where provisions are made for circulating the coolant. Basically the experiment involves the measurement of the single cell temperature coefficient $\alpha_i(r,T)$ for the various locations in the core and reflector, corresponding to a uniform temperature T .

Measurements of $\alpha_i(r,T)$ for each cell are obtained by separately heating this particular cell, while the remaining cells are held at a constant temperature by operation of the coolant circulating system.

From this data the temperature effects for the following conditions can then be evaluated.

A. Isothermal Temperature Coefficient: The average isothermal temperature coefficient can be expressed in terms

of the single cell coefficients since

$$\alpha_{\text{total}} = \sum_{i=1}^n \alpha_{i,c}(r, T_u) + \sum_{j=1}^m \alpha_{j,\text{ref}}(r, T_u)$$

where:

$\alpha_{i,c}(r, T_u)$ is the average temperature coefficient
of the i^{th} cell of the core ($i = 1, 2, \dots, n$).

$\alpha_{j,\text{ref}}(r, T_u)$ is the average temperature coefficient
of the j^{th} cell of the reflector ($j = 1, 2, \dots, m$).

T_u is constant.

B. Non-isothermal Temperature Coefficient: The average temperature coefficient of a reactor operating at power levels sufficient to cause non-isothermal temperature conditions is given by

$$\alpha_{\text{total}} = \sum_{i=1}^n \alpha_{i,c}(r, T_s) + \sum_{j=1}^m \alpha_{j,\text{ref}}(r, T_u)$$

where:

T_s depends on the cell position.

This response implies that the temperature change is uniform throughout the reactor core and reflector as would be caused by a small change in coolant inlet temperature.

C. Non-uniform Temperature Coefficient: The temperature response for a non-uniform temperature change may also be described in terms of the single cell coefficients. For cases where the power level is changed while flow rate is held constant or vice versa, the temperature rise will vary in proportion to the flux distribution so that

$$\alpha_{\text{total}} = \frac{1}{\Phi} \sum_{i=1}^n \alpha_{i,c}(r, T_s) \Phi(r)$$

where:

$\frac{\Phi(r)}{\Phi}$ is the lateral flux distribution.